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PAR 253

Stereogram Printer Optical Development

20 June 1969

Funded June 69

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PROJECT AUTHORIZATION REQUEST

PAR 253
20 Jun 69

SUBJECT: Stereogram Printer Optical Development

TASK/PROBLEM

1. Study and evaluate an optical system for the reproduction of a stereo-image pair in stereogram format. Fabricate necessary kluge equipment for conducting necessary photographic tests.

PROPOSAL

2. Introduction:

a. For maximum information retrieval from stereo mission material now being acquired, special complex and expensive stereo registration equipment has been developed. Although this equipment would permit comfortable stereo fusion for observers by scale matching and image rectification, its expense restricts its availability to a limited number of users.

b. The importance of making fuller use of currently available stereo materials has prompted consideration recently of combining the registration technique described above with a special optical printer system that could produce stereograms* in quantity. This approach, if successful, would make high-quality stereo views of selected targets readily available to PI's for use in low magnification, low-cost, desk-top stereoscopes.

3. The following are considered to be requirements for such a printer optical system:

a. High-quality reproduction of state of the art imagery that results in maximum information preservation.

b. Accurate matching of pairs by the system after only approximate image matching by the operator.

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* Stereogram - A matched pre-aligned stereo pair readily capable of fusion by an observer using a simple stereo viewer.

c. A high production rate resulting from the capability for a relatively short exposure time on print stock materials such as SO-239 reversal film. How short an exposure can be made is an unknown that will be considered in the early phases of this PAR. Since multiple duplication of each stereo scene is an important objective, consideration will be given to roll feeding of the print stock when the design of a production printer is undertaken.

4. It is the intent of this PAR to prove the feasibility of an optical system that is necessary to the concept of a stereogram enlarging printer. The decision to design and fabricate such a printer would be based on the results obtained under this PAR.

5. Preliminary Study-Establishing Optical Design Parameters:

a. The results of a brief study indicate that the nominal magnification for this system should fall in the 5-15X range. The magnification that is chosen will be determined by the print format desired and the coverage of original imagery that is required. This magnification will probably be variable over a suitable range.

b. The resolving power achievable for a system working within this magnification range should be better than 200 cycles/mm when reproduced from a USAF 1951, standard-three-bar, high-contrast target.

c. The system will be zoom anamorphic; that is, its magnification will be continuously variable in one plane over a finite range. It is now believed that a 2:1 anamorphism range will be adequate. The overall magnification will be independently variable, as was already indicated. These magnification changes will permit necessary scale matching and the approximate image rectification required for comfortable stereo fusion by an observer using a simple stereo viewer.

d. The relative aperture of the printer objective lenses will be established as design development progresses.

e. The illumination system will probably be a specular, condenser-type system using a tungsten lamp to provide necessary source intensity control. This system must necessarily be tailored to the objective lens parameters.

6. Objective and Condenser Lens Design:

a. Before this proposal was prepared, three basic types of variable magnification anamorphic systems were considered:

(1) The first type consisted of a positive and negative element, each having cylindrical power; in this system, magnification is varied by rotating the cylinder axes with respect to each other. The system was rejected, however, because 1X, or neutral anamorphic reduction, could not be achieved. In addition, a problem of focal plane instability, might also make this approach impossible.

(2) The second type of system considered involved a zoom attachment in the classical sense, except that all anamorphic elements had cylindrical power only.

(3) The third type of system consisted of wedge prisms placed in a collimated beam. To obtain 2X magnification variation with sufficiently high image quality, both two-element and three-element wedge prisms would be required, plus a doublet collimator at the long conjugate side of the system. The projection lens would be used at infinity to provide collimation on the short conjugate side of the wedge prisms.

b. Both the second and third systems are believed feasible, and can be three-color achromatised in one system about as well as in the other. The zoom cylinder system would probably introduce some distortion, possibly as much as 1/2 percent; the wedge system, on the other hand, should not introduce any. Due to the collimator doublet, the wedge system would require more elements. Alignment problems would probably be somewhat

easier for the cylindrical system. After considering the above facts, it is felt that a final selection should not be made at this time, as the relative costs of two systems have not been thoroughly considered and could be an influencing factor.

7. Evaluation of Objective Lens Formula. The projection lens formula will be theoretically evaluated for optical transfer function before any effort is spent in lens manufacture.

8. Fabrication of Formula Sample Optics. Following satisfactory evaluation of the objective lens formula, manufacture of sample projection and condenser optics will be undertaken. The mounting for the projection optics will be such that it can be utilized later in a breadboard or prototype printer.

9. Construction of a Single-Beam Printer Kluge. A printer kluge with a single beam will be designed and built for use as an optical bench upon which to conduct photographic tests. It is anticipated that this kluge will consist of a highly rigid frame isolated from building vibrations. A lamphouse with provisions for mounting the condenser optical element into it will be designed. No transport system will be provided for handling the original film, nor will there be a print stock handling system other than an easel that is adequate for test purposes. Effort will be made to incorporate into the kluge as much flexibility as possible from a test operation standpoint. All test operation adjustments will be manually controllable, and no effort will be made to automate the system or to couple it with any other equipments or systems.

10. Photographic Testing. The testing that is conducted will involve producing matched stereograms, one half at a time, from stereo scene pairs. The following capabilities will be tested:

a. Reproduction of high-quality aerial scenes with high information retention.

b. Rectification of dissimilarities in scene pairs that result from such factors as different obliquity angles, different panning angles, or different camera-to-target distances. Rectification is considered to be adequate when comfortable stereo fusion is possible anywhere on the print format without the need to change the alignment of the viewing optics or the stereo scenes.

c. Attainment of better than 200 cycles/mm, high-contrast, three-bar target resolution throughout the anamorphic zoom range.

d. A reasonably short exposure time for printing such materials as SO-239 from typical originals.

PROGRAM OBJECTIVES

11. Determine the optical feasibility of an Enlarging Stereogram Production Printer.

SCHEDULE

12. A tentative schedule covering the major phases of effort is shown in Figure 1. Changes in this schedule that may be necessary as work progresses will be reviewed with the customer.

TENTATIVE SCHEDULE

Stereogram Printer
Optical Development

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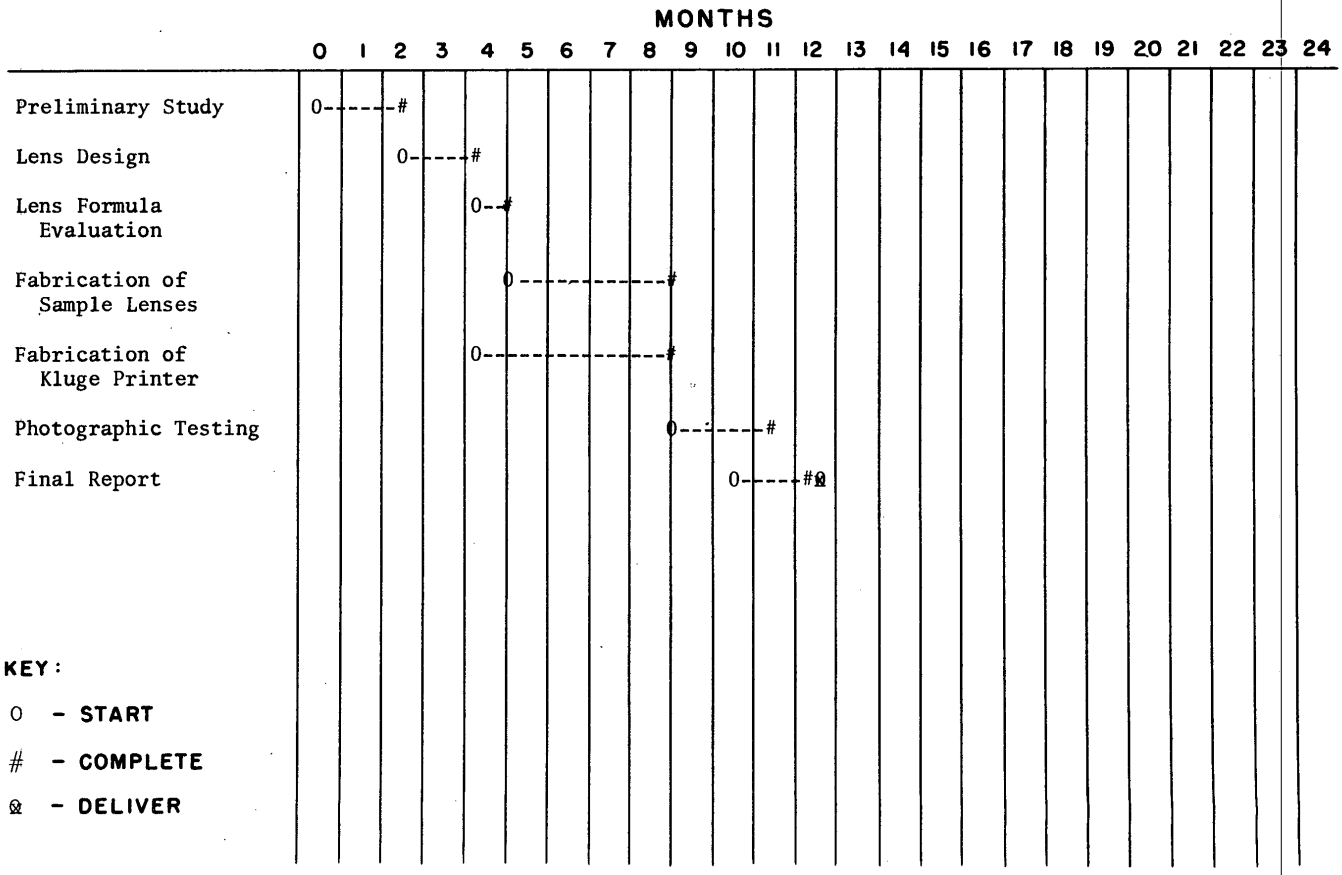
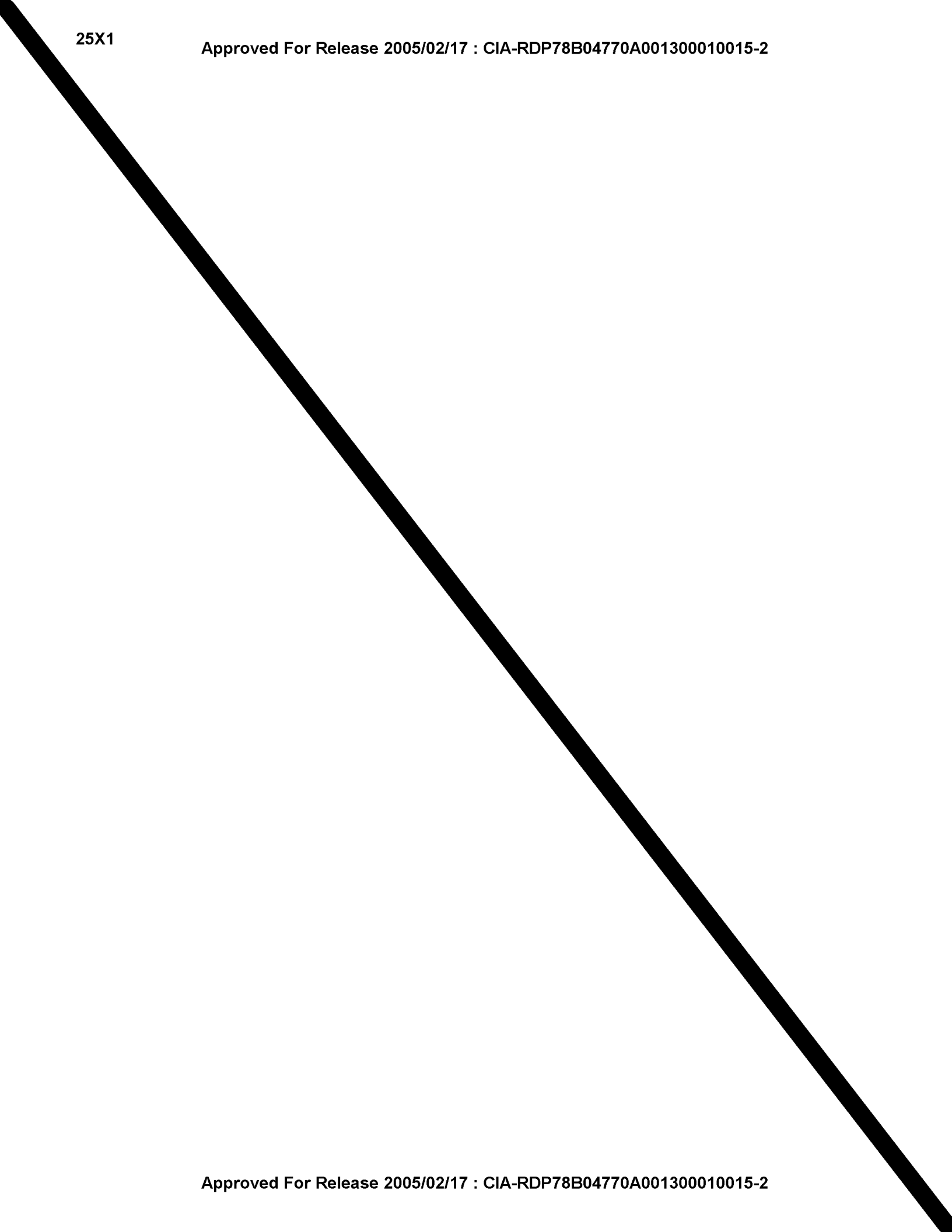


Figure 1



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